

REMARKS

Claims 1-47 were submitted with the application as filed. Claims 48-66 were submitted in a preliminary amendment mailed on August 3, 2004. Claims 67-76 were submitted in a second preliminary amendment mailed on July 28, 2005, which was not considered by the Office prior to mailing of the present Office Action on August 5, 2005. As of November 30, 2005, Private PAIR did not show that the July 2005 preliminary amendment was disapproved. Because the July 2005 preliminary amendment was received by the USPTO prior to mailing of the present action and the amendment has not been disapproved under 37 CFR 1.115(b), it is believed that the status of claims 67-76 is “previously presented.” The claims have been so designated in this reply. As explained below, Applicants believe that claims 67-76 are patentable over the cited art.

Claims 1-76 are now pending. Claims 1-66 have been examined. Claims 1-32 and 34-66 have been rejected. Claim 33 was objected to but would be allowable if written in independent form, including all limitations from its independent and intervening claims. Applicants appreciate this indication of allowability.

Independent claims 43, 48, 57, and 67 have been amended to recite “contacting at least the metal with an etching solution, wherein the contacting comprises at least one of immersing, spraying, dipping, spin on contact, and using a thin film reactor.” Support for these amendments is found at page 4, fourth paragraph; page 10, third paragraph; and original claim 24. Other claims have been amended to make minor clerical changes.

All rejected claims were rejected based on at least one of US Patent No. 6,355,153 issued to Uzoh et al. and US Patent No. 6,692,548 issued to Ma et al. Only the rejections of dependent claims 25-27 and 35 involved additional references. Claims 25-27 were rejected over a combination of Uzoh et al. and US Patent No. 6,329,284 issued to Maekawa. Claim 35 was rejected over a combination of Uzoh et al. and US Patent No. 6,716,753 to Shue et al.

As explained below the pending claims are patentable over these references. Of note, both Uzoh et al. and Ma et al. disclose etching or polishing solutions that are used with pad-based planarization tools such as CMP apparatus.

Rejections based on Uzoh et al.

First, concerning the rejection of independent claims 1 and 38, the Office points to Uzoh et al., column 7, lines 54-56 and fig. 3Biib as disclosing etching metal from the substrate to a

position below an upper level of the exposed dielectric layer. Figure 3Biib does indeed show that some metal is not present at a position below an upper level of the exposed dielectric layer.

However, Applicants respectfully dispute that the missing metal resulted from etching. To the extent that there is a recess in metal below a dielectric region in Uzoh's process, that recess was present when the metal 24 was deposited as shown at Fig. 3Biia. See Uzoh's discussion of the progression at column 7, line 41 to column 8, line 32. While it is not stated in so many words, it is clear from the progression of figures and the associated discussion of the deposition, polishing, and reposition processes that the cavities in question were formed when the metal layer 24 was first deposited as shown in Fig. 3Biia. Thereafter, when some planarization was performed to expose the top surfaces of a barrier layer 4, the contours of the cavities within trench/via regions did not change. So there is no reason to assume from Uzoh's disclosure that any etching occurred within the cavities during the planarization step to expose the barrier layer 4.

In view of this, it is respectfully submitted that the cited portions of Uzoh et al. fail to teach or reasonably suggest "etching metal from the substrate to a position below an upper level of exposed dielectric in the layer." Withdrawal of the 102 rejections based on Uzoh et al. is therefore respectfully requested. This includes not only independent claims 1 and 38, but the dependent claims 2-9, 14-24, 28-32, 34, 36-37, and 39-42 as well.

Applicants note that claims 10-13, 25-27, and 35 were rejected over various combinations of references that included Uzoh et al. The other cited references (Ma et al., Maekawa, and Shue et al.) also fail to overcome the deficiencies above. Neither Maekawa, nor Shue show "etching metal from the substrate to a position below an upper level of exposed dielectric in the layer by contacting at least the metal with an etching solution." Ma et al. fails to disclose forming capping layers in the manner claimed and has little in common with Uzoh et al. to suggest combining the references in a manner that would suggest the methods of claims 1 and 38. As the combinations of cited references fail to suggest the claimed invention, it is respectfully submitted that claims 10-13, 25-27, and 35 are patentable over the cited art. Withdrawal of the rejection is respectfully requested.

Rejections based on Ma et al.

Claims 43-66 were rejected as anticipated by the Ma et al. patent. According to the Office, the operation of etching metal from the substrate to a position below an upper level of exposed dielectric (claim 43) is disclosed at column 8, lines 55-60 and column 9, lines 15-37. The description appearing at these locations pertains the composition of a CMP slurry. In fact,

the entire specification of Ma et al. pertains to CMP and CMP slurries. Obviously, the slurry described in the cited sections of Ma et al. would etch metal from a substrate by CMP. Any contact between the metal and the slurry would occur via CMP.

Amended claims 43, 48, 57, and 67 recite “contacting at least the metal with an etching solution, wherein the contacting comprises at least one of immersing, spraying, dipping, spin on contact, and using a thin film reactor.” None of the recited modes of contact would be necessarily realized using the pad-based CMP polishing described in Ma et al. For example, it is well understood in the art that spin on contact of an etching solution is a fundamentally different process than CMP and related processes. See e.g., US Patents 6,309,981 and 6,586,342, which describe spin on type processes and were incorporated by reference in the specification of the present application. Withdrawal of the 102 rejections based on Ma et al. is respectfully requested. This includes not only independent claims 43, 48, 57, and 67, but the dependent claims 44-47, 49-56, 58-55, and 68-76 as well.

It is also worth noting that to the extent Ma et al. shows metal having been removed to a position below exposed dielectric in Fig. 5, Ma et al. describes this as “dishing” and teaches that it is to be minimized. See column 7, lines 1-13.

Applicants also note that independent claims 48, 57, and 67 do not recite “etching metal from the substrate *to a position below an upper level of exposed dielectric*”. Nevertheless, they are still patentable over Ma et al., as they recite “contacting at least the metal with an etching solution, wherein the contacting comprises at least one of immersing, spraying, dipping, spin on contact, and using a thin film reactor.”

Applicants further note that to the extent that Uzoh et al. describes material removal in Fig. 3Biib and elsewhere this result occurs by planarizing using either “the pad type material 20” or “a CMP pad having fixed abrasive particles.” See column 7, lines 54-64. Applicants understand that Uzoh et al. was not used to reject claims 43-66, but merely make this point to illustrate that the cited art as a whole fails suggest etching by immersing, spraying, dipping, spin on contact, or using a thin film reactor. Original claim 24 does recite “contacting the substrate with an etching solution comprises dipping, spraying or using a thin film reactor” and it was rejected on the basis of Uzoh’s description of an “acidic bath” at column 9, lines 23-24. However, this bath is described by Uzoh et al. as a plating bath in which a pad-based planarization technique appears to be the only material removal mechanism; i.e., the solution itself is not used for etching. See e.g., column 10, lines 18-24.

As a general point, there are numerous reasons why etching by the modes recited in claims 43, 48, 57, and 67 is more desirable than etching by CMP. Dishing is just one of these. The high expense of CMP is another. Hence the invention as presently claimed in claims 43, 48,

57, and 67 provides significant advantages over the CMP and pad-based techniques described in the Ma et al. and Uzoh et al. patents.

Conclusion

Applicants believe that all pending claims are allowable and respectfully request a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

Respectfully submitted,
BEYER WEAVER & THOMAS, LLP



Jeffrey K. Weaver
Reg. No. 31,314

(510) 663-1100
P.O. Box 70250
Oakland, CA 94612-0250